

501 PORTLAND CEMENT CONCRETE PAVEMENT

501.01 DESCRIPTION

Work consists of constructing a pavement composed of Portland cement concrete, with reinforcement, on a prepared base course, in accordance with these specifications and in conformity with the lines, grades, thicknesses, and cross sections shown in the contract documents.

501.02 MATERIALS

Portland cement concrete, Class E - 817
Welded wire fabric - 812.01
Tie Rod Assemblies and Tie Rods - 807.04
Load transfer assemblies - 807.03
Preformed expansion joint filler - 807.01
Joint-sealing materials - 807.02(A) or (B)
Impervious subgrade materials - 821.16
Curing materials and admixtures - 814
Fly Ash - 821.09

501.03 PROPORTIONING

The Contractor shall submit a mix design conforming to 817.01 for the approval of the Engineer. The approved mix design shall not be changed except as provided below.

(A) ADJUSTMENT FOR VARIATION IN FINENESS MODULUS (FM). If the FM of the fine aggregate varies by more than 0.20 from the established value, the mix design shall be adjusted as provided in 817.01.

(B) ADJUSTMENT FOR VARIATION IN WORKABILITY. If it is impossible to obtain PCC of the desired workability with proportions approved by the Engineer, the Contractor shall make such changes in aggregate weights as necessary, provided that in no case shall the cement content originally designated be changed except as provided below.

(C) ADJUSTMENT FOR VARIATION IN CONSISTENCY. If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content shall be increased as directed by the Engineer so that the maximum allowable water-cement ratio will not be exceeded.

(D) ADJUSTMENT FOR VARIATION IN YIELD. If cement content of the PCC determined by AASHTO T 121 varies more than plus or minus 2 percent from the approved design mix, the proportions shall be adjusted by the Contractor and approved by the Engineer to maintain a cement content within these limits. The water content shall not exceed the maximum approved.

(E) ADJUSTMENT FOR NEW MATERIALS. Change in source or character of the materials shall be made only after tests on trial mixes and with the Engineer's written approval.

Aggregates and portland cement shall be proportioned by weight. Water may be proportioned by volume or by weight. Batch weights of aggregates for the concrete shall be corrected for free moisture, as calculated from moisture determinations performed by the Contractor and witnessed by the Engineer.

These moisture determinations shall be made as frequently as deemed necessary by the Engineer.

Suitable means shall be provided for accurately determining the amount of moisture in the aggregates.

501.04 EQUIPMENT

PCC Equipment - 905

501.05 PREPARATION OF GRADE

After the roadbed has been graded and compacted, the grade shall be fine graded to correct elevation, extending the work as necessary beyond each edge of the proposed concrete pavement.

501.06 SETTING FORMS

(A) BASE SUPPORT. The foundation under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with base course material for a distance of 18 inches on each side of the base of the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected by retamping or by trimming as necessary.

(B) FORM SETTING. Forms meeting the requirements of 905.03(A) shall be set at least 200 feet in advance of the point where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically, or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than 3 pins for each 10 foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. On curves having a radius of less than 250 feet, wood forms of dressed, well-seasoned lumber having a nominal thickness of not less than 2 inches and a width not less than the depth of the pavement to be placed against them may be used subject to the approval of the Engineer.

The forms shall not deviate from true line by more than 1/4 inch nor from true grade by more than 1/8 inch at any point. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and coated with a form release agent or oiled prior to the placing of concrete.

(C) GRADE AND ALIGNMENT. The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

501.07 CONDITIONING OF BASE COURSE

After the forms have been finally set, the elevation of the entire base course shall be tested by means of an approved template meeting the requirements of 905.04 held in a vertical position and moved backward and forward on the forms. Any excess material indicated by the template shall be removed and depressions shall be filled with approved material. After these adjustments have been made, the base course within the forms shall be compacted in accordance with 209.06. If construction methods are used that involve moving heavy equipment over the prepared base course resulting in heaving or rutting of the base course, the base course shall be protected by mats or boards. The prepared base course shall be maintained, compacted, and shaped to drain at all times.

When directed by the Engineer, the Contractor shall furnish and apply waterproofing materials in accordance with 617 upon the roofs and walls of all structures such as cellars, vaults, elevators, and coal

chutes that may be encountered in any type of work. Materials shall be as specified in 802.06. Prior to waterproofing, all joints in the structure shall be sealed in accordance with 501.19. Payment for waterproofing and sealing joints will be included under the PCC pavement item.

After the base course has been constructed and before the concrete is placed, the base course shall be entirely covered with a layer of impervious material meeting the requirements of 821.16.

Impervious material shall be lapped at least 12 inches at the ends and sides. After being placed on the base course, the impervious material shall be maintained reasonably intact and shall not be damaged.

Poles, manholes, or other structures projecting through the concrete shall be given a heavy coating of asphalt meeting the requirements of 802.04 or 802.05 prior to placing the concrete.

501.08 HANDLING, MEASURING AND BATCHING MATERIALS

The supplier of the concrete shall have sufficient plant capacity and transportation apparatus to provide delivery at the rate required to insure that the depositing of the concrete will be continuous.

Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next, which shall not be allowed to cone down over the next lower layer. Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or nonuniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts conforming to the approved mix design. Cement shall be measured by weight. Separate scales and hoppers shall be used for weighing the cement with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Batching shall be so conducted as to result in weights of each material required within tolerances of 1 percent for cement and 2 percent for aggregates. The accuracy of measuring the water shall be within a range of error of not over 1 percent.

Unless otherwise permitted by the contract, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type.

Methods and equipment for adding air-entraining agent or other admixtures to the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixes within a tolerance of plus or minus 3 percent.

501.09 MIXING CONCRETE

(A) GENERAL. The concrete may be mixed wholly or in part in paving mixers, stationary mixers or truck mixers located at a central plant or at the site. Ready-mixed concrete shall conform to the requirements of AASHTO M 157.

Concrete mixed under these specifications shall be of uniform consistency and such that the mortar will cling to the coarse aggregate. It shall not be sufficiently wet to flow readily or segregate, nor shall it be

of a mealy or too dry consistency.

The interval between batches shall be such that the concrete in place does not partially harden and in no case shall this interval exceed 30 minutes. The time interval between admission of cement to the aggregate and final discharge of the concrete shall not exceed one and one-half hours. The time interval shall not exceed one hour for hot weather (85°F or above) construction. Concrete which has developed an initial set shall not be used. Retempering of partially set concrete by mixing with additional water is prohibited.

Delivery of concrete materials shall be controlled by tickets issued to the driver and signed by the authorized representative of the Engineer at the plant. These tickets shall contain information as directed by the Engineer. Upon arrival at the job site, the tickets shall be given to the Engineer.

(B) TRUCK MIXING. Truck mixers shall meet the requirements of 905.02.

All wash water shall be dumped before reloading the truck with concrete or concrete materials. No truck shall be loaded which contains free water in the drum. In depositing aggregates into the mixer drum, and in fastening the charging gate, no free water in excess of that found in the moisture determinations shall be admitted into the mixer drum.

Mixing water and wash water for truck mixed PCC shall be stored in watertight tanks, separate from the mixing drum, and shall be equipped with an approved, operable, calibrated gauge on each tank. Water tanks shall be completely filled at plant. If, on arrival at the job, inspection reveals a drop in the water level, the batch may be rejected. All mixing water, other than free moisture in the aggregates, shall be added to the mix in the presence of the Engineer. Prior to adding mixing water to the drum the mixing water gauge valves shall be set to show the water level in the tank, and the gauge shall be read and recorded in the presence of the Engineer. No wash water shall be used until all concrete in the drum has been discharged.

The Contractor shall provide a level area for all truck mixing.

After all materials, including water, have been added to the mixing drum, mixing shall be in accordance with latest recommendations of the mixer manufacturer for a minimum of 70 and a maximum of 100 revolutions excluding revolutions at the agitation speed. The mixing speed shall not be less than 4 rpm and not more than 18 rpm.

If the slump is less than that desired, additional water may be added if permitted by the Engineer. After addition of the water, the mixing drum shall be rotated 20 to 30 revolutions at the mixing speed before the discharge of the concrete. After the addition of water the number of revolutions shall not exceed 100, except for concrete mixes containing coarse aggregates which do not wear more than 25 percent as determined in accordance with Resistance to Abrasion of Small Size Coarse Aggregate, AASHTO T-96, for which the number of revolutions shall not exceed 130.

The rate of discharge of concrete from the mixer drum shall be controlled by the speed of rotation in the discharge direction with the discharge gate fully open.

(C) TRANSIT MIXING. Transit mixing shall be in accordance with 501.09(B) except:

Mixing water shall be accurately measured at the proportioning plant and added to the mixing drum at the plant. Mixing may be done at the plant or at the job site, at the option of the Contractor. In either case, the mixer drum shall be rotated at the agitation speed from the time the truck leaves the plant until it arrives at the job site.

(D) CENTRAL MIXING. When central mixing is used, the proportioning and mixing plant shall meet all the requirements governing the handling, proportioning and mixing of concrete materials in a stationary mixer in conformance with AASHTO M 157.

The mixed concrete shall be conveyed from the central mixing plant to the site of the work in agitator or nonagitator trucks conforming to 905.02. The time elapsing from the time cement is added to the mix until the concrete is deposited in place at the site work shall not exceed 45 minutes when the concrete is hauled in nonagitating trucks, nor 90 minutes when hauled in truck mixers or truck agitators, except that in hot weather (85°F or above) the time interval shall not exceed one hour.

(E) PAVING MIXERS. Paving mixers having a rated capacity of 27 cubic feet or over may be used when approved by the Engineer.

(F) HAND MIXING. Hand mixed batches of concrete may be allowed only in an emergency. The total quantity of such batches shall not exceed 1/2 cubic yard. Hand mixing shall be subject to the immediate direction and approval of the Engineer.

501.10 LIMITATIONS ON MIXING

(A) NIGHT WORK. Concrete shall be placed during daylight hours unless otherwise permitted by the Engineer. If the placement of concrete is permitted at night, an adequate lighting system shall be provided for both placement operations and inspection testing. A minimum of 20 foot-candles illumination at the slab elevation shall be provided at all areas within both the placement and testing site. A suitable light meter shall be provided to the Engineer for approval. In addition, before any initial slab placement operation, a test run shall be made to insure that the specified illumination is provided. If a portable generator is used, an emergency backup generator shall be available at the job site.

(B) COLD WEATHER CONSTRUCTION. When the forecast of the U.S. Weather Bureau indicates that the temperature is expected to be less than 50°F during the 24 hour period following the placing of the concrete, a Type C accelerator meeting the requirements of 814.05(A) shall be incorporated in the concrete mix at the batching plant.

No concrete shall be placed without permission of the Engineer when the ambient temperature reaches 40°F and is descending or when the U.S. Weather Bureau forecasts that the temperature will drop below 40°F during the 24 hour period following the placing of the concrete. If the Engineer permits concrete placement at temperatures lower than those specified above, the following requirements shall be met:

1. The temperature of the mixed concrete shall not be lower than 50°F and not more than 90°F at the time of placement.

2. As soon as the concrete has hardened sufficiently to prevent marring, and after curing materials have been placed, all surfaces and edges shall be covered with an insulation blanket conforming to 814.02(D) or other suitable material. Proper provisions shall be made to hold the material in place for at least 72 hours or until tests of field cured flexural strength beams indicate that the concrete has attained 450 psi flexural strength.

3. No concrete shall be placed on frozen subgrade nor shall frozen aggregates be used in the concrete.

No direct payment will be made for incorporating an accelerator in the concrete or for the insulated curing required for cold weather construction. The cost of this work will be included in the contract unit price for the various portland cement concrete pay items.

The Contractor will be held responsible for any defective work caused by freezing. Concrete damaged in any manner shall be removed and replaced without cost to the District of Columbia.

(C) HOT WEATHER CONSTRUCTION. The concrete temperature at the time of placing shall be within the range of 50°F to 90°F. If the required consistency cannot be maintained, the mix shall be adjusted in accordance with 501.03. The temperature of the cement at the time of batching shall not exceed 160°F.

501.11 PLACING AND CONSOLIDATING CONCRETE

The concrete shall be deposited on the grade in such manner as to require as little rehandling as possible and to prevent segregating of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement and heavy equipment will be operated upon the existing lane of pavement, that lane shall have attained a flexural strength of 550 psi or a compressive strength of 3500 psi. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 3 days.

Concrete hauling units will not be allowed to operate over the soils base when, in the opinion of the Engineer, they will damage or change the uniformity of the soils base.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

All concrete shall be consolidated with spud vibrators meeting the requirements of 905.07. Concrete shall be thoroughly consolidated throughout the entire slab. The vibrator shall not come into contact with the joints, load transfer devices, or the base course. In no case shall the vibrator be operated longer than 5 seconds in any one location.

Any evidence of honeycomb or lack of consolidation shall be sufficient reason to require removal and replacement of the concrete.

Concrete shall be deposited as near to the expansion joints as possible without touching them. It shall then be shoveled against both sides of the joint simultaneously, maintaining equal pressure on both sides. Care shall be taken that it is worked under the load transfer devices. The concrete shall not be dumped directly upon or against the joints, nor shall it be shoveled or dropped directly on top of the load transfer devices. In placing the concrete against expansion and contraction joints and in operating a vibrator adjacent to them, workmen shall avoid stepping upon or disturbing in any way the joints or load transfer devices, either before or after they are covered with concrete. If any of the dowel bars are displaced, they shall be realigned before the finishing machine passes over them.

A self-propelled slip form paving machine may be used if approved by the Engineer. It shall be self-propelled and be designed for the specific purpose of placing, consolidating, and finishing concrete pavement slabs true to grade and cross section in one complete pass without the use of fixed side forms. The machine shall be equipped with means for spreading the concrete to a uniform depth before it enters the throat of the machine. The machine shall vibrate the concrete internally with sufficient intensity to consolidate the concrete throughout its entire depth and width.

501.12 STRIKE-OFF OF CONCRETE AND PLACEMENT OF

REINFORCEMENT

Following the placing of the concrete, it shall be struck off with a mechanical spreader meeting the requirements of 905.05 to conform to the cross section shown on the plans. Reinforced concrete pavement shall be placed in two layers. The entire width of the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric conforming to 812.01 may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, screeded and consolidated. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense.

Reinforcing steel shall be free from dirt, oil, paint, grease, loose mill scale, and loose or thick rust which could impair bond of the steel with the concrete.

Unless otherwise shown on the plans, wire fabric reinforcement weighing 30 pounds per 100 square feet shall be used in pavement 6 inches in depth and wire fabric reinforcement weighing 50 pounds per 100 square feet shall be used in pavement 8 inches or greater in depth.

The sheets of reinforcement shall be tied at the laps so as to be held in place and shall extend to within 2 inches of the ends of the slabs and to within 2 inches of the edges of the slab or through the cement concrete curbing to within 2 inches of the back of the curb when the curb is poured monolithically with the slab. Reinforcement shall not extend across expansion joints, contraction joints or planes of weakness. Wire fabric reinforcement shall be placed approximately 2 inches below the finished surface of the slab with the larger wires running in the longitudinal direction.

Additional reinforcement meeting the above specifications shall be placed over cuts as directed by the Engineer. Additional wire fabric reinforcement, when used, shall be placed approximately 2 inches above the bottom of the slab. This work shall be considered "Additional Wire Fabric Reinforcement."

501.13 FINAL STRIKE-OFF, CONSOLIDATION AND FINISHING

(A) GENERAL. The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straightedging, and final surface finish. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing, straightedging, and making corrections as hereinafter specified, shall be provided by the Contractor.

Finishing machines meeting the requirements of 905.06 shall be used to finish the pavement.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(B) MACHINE FINISHING. The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been placed and consolidated in conformance with 501.11 and 501.12, it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper consolidation and leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish.

During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length.

(C) FINISHING AT JOINTS. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as specified.

After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated coarse aggregate shall be removed from both sides of and off the joint. The screed shall be lifted and brought across the joint. Then the forward motion of the finishing machine shall be resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated coarse aggregate immediately between the screed or on top of the joint.

After the concrete has been placed on both sides of the joint and struck off, the installing bar or channel cap shall be slowly and carefully withdrawn leaving the preformed filler in place. After the installing bar or channel cap is completely withdrawn, a tapered wooden strip shall be temporarily inserted in the joint, and freshly mixed concrete shall be worked in any depressions left by the removal of the installing bar. The installing bar shall be cleaned and oiled prior to each installation of a joint.

(D) HAND FINISHING. Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

(1) In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs. Narrow widths, areas of irregular dimensions or small areas where operations of mechanical equipment is impractical may be finished by hand methods.

(2) When finishing by hand is permitted the concrete shall be placed to the full thickness required in successive batches for the entire width between construction joints shown on the plans. The concrete shall be vibrated internally during placing as specified herein, and shall be screeded off with a steel shod screed weighing not less than 15 pounds per linear foot. The screed shall be constructed so that it can be set accurately to whatever roadway crown is required. It shall be operated by a sawing motion and moved forward on substantial screed supports set at proper elevations. The shape and construction of the screed shall meet the approval of the Engineer. The screeding shall be repeated, as required, accompanied by tamping, or other operations necessary to provide an even, approved surface ready for floating.

(E) FLOATING. After screeding is completed, the surface shall be floated with a float meeting the requirements of 905.09(C). The float shall be operated transversely with a combined longitudinal and transverse motion, with a sufficient number of passes to smooth all ridges and fill all depressions. Excess water and soupy material shall be wasted over the forms at each pass.

(F) SURFACE CORRECTION. After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface shall be tested in accordance with 501.16. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Surface corrections shall continue until the entire surface is found to be free from observable departures and the slab conforms to the required grade and cross section.

(G) FINAL FINISH. After the concrete has been floated and the surface corrected, it shall be finished by dragging the surface in a longitudinal direction with burlap meeting the requirements of 814.01. This drag shall be worked with a longitudinal motion, care being used not to permit the edges to dig into the surface of the concrete or to work the crown out of the pavement.

After the water sheen has practically disappeared, but previous to any initial set, the surface shall be given the final finish by brooming with a broom meeting the requirements of 905.09(D). The broom shall be moved from one side of the pavement to the other without interruption. The travel of the broom shall overlap a small amount. The brooming shall be perpendicular to the center line of the pavement and so executed that the corrugations thus produced will be of uniform character and width and not more than 1/8 inch in depth, with the resulting surface free from objectionable depressions or projections that might be formed by improper handling. The brooming must be completed before the edges of the pavement and joints are rounded.

The surface of the pavement adjacent to all curbs, i.e., in the flowline of the gutter, shall be troweled and finished with hair brooms or hair brushes conforming to 905.09(D) or (E).

(H) EDGING AT FORMS AND EXPANSION JOINTS. All joints and edges shall be rounded to 1/4-inch radius.

501.14 JOINTS

(A) GENERAL. Longitudinal and transverse joints shall be located and constructed as shown on the contract documents. All joints shall be perpendicular to the pavement surface and perpendicular, radial, or parallel to the roadway centerline or as directed.

The sequence of construction of various slabs shall be determined by the Contractor with the approval of the Engineer.

(B) LONGITUDINAL JOINTS. Longitudinal joints shall be either formed or sawn. Joints between separately constructed roadway slabs and curb and gutter sections shall be formed.

Longitudinal joints shall have tie rods or keyways and tie rod assemblies meeting the requirements of 807.04, constructed and spaced as shown in the contract documents. No tie device shall be placed closer than 18 inches to a transverse joint.

The initial installation of the tie rod assembly shall be firmly held in place by tap bolts and steel washers. Tap bolts shall be in place during the fine grading. The tap bolts shall then be removed and the remainder of the tie rod assembly installed.

The edges of the slab first constructed shall be given a heavy coating of bituminous material meeting the requirements of 802.04 or 802.05 prior to pouring the adjacent slab.

(C) TRANSVERSE JOINTS

(1) GENERAL. No transverse joint shall be formed within 10 feet of an existing pavement, bridge or approach slab. Expansion joints shall be placed 10 feet back from the end of the new pavement where it abuts an existing pavement.

(2) TRANSVERSE EXPANSION JOINTS. Transverse expansion joints shall be composed of load transfer assemblies conforming to 807.03, and 3/4 inch thick preformed joint filler conforming to the requirements of 807.01, and shall be constructed and placed as shown in the contract documents.

Unless otherwise shown on the plans, expansion joints shall be placed at each end of a block, at tangent points of curves and/or curb corners and at intervals of approximately 30 feet. The Engineer may require the spacing of joints to vary at intersections, islands, and circles or other similar locations.

Joints shall be constructed perpendicular to the center line of the pavement so as to produce straight joints within an allowable variation of 1/4 inch in 10 feet and a discrepancy with the pavement surface of not more than 1/8 inch in 10 feet. The joint will be checked with a 10 foot straightedge.

The joint filler shall be securely held in place to insure against displacement during construction and the top edge of the filler shall be protected with a U-shaped metal cap while the concrete is being placed and finished. The joint filler shall be punched to admit dowel bars and to assure a tight fit.

The preformed expansion joint filler shall be continuous across the full width of the pavement and through the curb and gutter and shall extend from the soils base to 1/2 inch below the finished pavement surface.

Where joint filler is joined to the joint filler of an adjacent, previously constructed slab, a perfect butt fit shall be accomplished or a U-piece of thin gage metal shall be placed to prevent the infiltration of cement mortar into the joint. Any section of expansion joint filler extending through any curb shall be so cut that the elevation of the top of the joint filler shall be 1/2 inch below the finished surface of the curb. The filler so cut shall be in one piece except when the curb is superimposed, in which case that portion above the flow-line level of the gutter may be a separate piece securely aligned and constructed so that it will function properly as an expansion joint and that the top seal will be watertight. The expansion joint filler shall conform to the section of the pavement where thickened edges are used.

After the concrete is cured and as soon as the forms for longitudinal construction are removed, the ends of all expansion joint filler shall be cleaned of concrete and the full width of the filler exposed for the full depth of the slab. No concrete shall be placed adjacent to a previously poured slab until the ends of the filler have been cleaned. The ends of the joint filler in the next slab to be poured shall be placed neatly and firmly against previously placed joint filler.

(3) TRANSVERSE CONTRACTION JOINTS. Transverse contraction joints shall be constructed and located as shown in the contract documents or as directed by the Engineer.

Any section of the contraction joint extending through the curb shall be formed as specified in 609.01(E)(6).

(4) TRANSVERSE CONSTRUCTION JOINTS. Transverse construction joints shall be formed where it is necessary to stop placing concrete for 30 minutes or longer, by staking in place a timber bulkhead of the same depth as the thickness of the concrete at right angles to the slab and finishing the concrete to the bulkhead. Tie rod assemblies shall be placed in transverse construction joints as shown in the contract documents. Where the location of the construction joint coincides with that of the expansion joint, the expansion joint shall be constructed with load transfer devices. If, due to an emergency, concrete placement must be stopped within less than 10 feet of a previously formed transverse joint, the concrete shall be removed to the joint prior to continuing the pouring of the slab.

(D) SAWN JOINTS. Longitudinal or transverse contraction joints may be sawn when permitted by the Engineer. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate to control cracking. The Contractor shall provide adequate artificial lighting facilities for night sawing. The grooves shall be cut to a minimum depth of 2 inches and the width shall be the minimum width possible with the type of saw being used, but in no case shall exceed 1/4 inch.

All joints shall be sawn before uncontrolled shrinkage cracking takes place and shall be regulated so that each joint is sawn 4 to 24 hours after placement of concrete. If necessary, the sawing operation shall be performed day and night, regardless of weather conditions. The concrete shall have hardened sufficiently to permit sawing without damage by blade action to the pavement surface or to concrete adjacent to the joint. Slight, though not excessive, raveling will be permissible along the joint edge. They shall be completed before placing concrete in the succeeding adjacent lane. The sawing of any joint shall be omitted if a crack occurs over load transfer devices prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints shall be sawn in sequence.

The slabs on either side of longitudinal joints shall be tied together by the installation of 1/2 inch tie rods 30 inches long placed across the longitudinal joint to a depth below the proposed saw cut and spaced in accordance with the contract documents. The tie rods shall be placed in a manner satisfactory to the Engineer. No tie rod shall be placed closer than 18 inches to a transverse joint.

(E) LOAD TRANSFER ASSEMBLY. All transverse expansion joints shall be provided with means for load transfer meeting the requirements of 807.03.

When dowel bars are used, they shall be of the sizes as shown on the standard drawings or contract plans, and shall conform to the requirements of 807.03(B). The dowels shall not be placed closer than 6 inches to a longitudinal joint. A dowel sleeve conforming to the requirements of 807.03 shall be placed on the greased end of each dowel.

The assembly shall be rigidly installed in a manner approved by the Engineer. The dowels shall be rigidly held in place parallel to the surface and center line of the pavement by supports that do not permit displacement by workmen or otherwise during construction. A tolerance of not more than 1/8 inch in 12 inches from correct alignment, either vertical or horizontal, will be permitted.

Special care shall be taken with the soils base course to establish the required cross section at the locations where assemblies are to be installed. If, for any reason, the soils base course is trimmed too low, or if there are any open spaces beneath the assembly, the assembly shall be removed, the base course backfilled, tamped firmly and the assembly reset.

501.15 TESTING

The consistency of the concrete will be checked by the slump test in conformance with AASHTO T 119. The slump shall not exceed 3". The determination will be made when and as often as deemed necessary by the Engineer to check the consistency of the concrete. The Contractor shall provide a slump cone, rod and a flat, non-absorbent surface in conformance with AASHTO T 119, for each project.

Test cylinders and beams will be made from each class of concrete, at the direction of the Engineer. Concrete for such specimens shall be furnished by the Contractor as directed.

Concrete test specimens for both compression strength testing and for flexural strength testing shall be made and cured in accordance with AASHTO T 23. Unless otherwise specified, the minimum 28 day compressive strength shall be 3500 psi. Flexural strength shall be tested in conformance with AASHTO T 177. Flexural strength shall be as hereinafter specified. The Contractor shall provide cylinder curing facilities at the project site that will allow initial 24 hour curing to be in conformance with AASHTO T 23, Section 9.2.

Air content of plastic concrete shall be tested in conformance with AASHTO T 196 or AASHTO T 152 as determined by the Engineer. The entrained air shall be 4 to 8 percent by volume.

The Contractor shall furnish and maintain for the concrete phase of the contract one pressure air type meter with necessary accessories meeting the requirements of AASHTO T 152, Type B. The air meter

shall be properly calibrated by an independent laboratory with a certification furnished to the Engineer.

501.16 SURFACE TESTING

The finished surface of the pavement shall conform to the grade, alignment and cross-section specified. The surface shall be tested with a straightedge meeting the requirements of 903.03 laid parallel to the center line of the pavement. Any deviation of the pavement surface in excess of 1/8 inch in 10 feet shall be immediately corrected. Extreme care shall be exercised to see that there is no deviation at joints. The Contractor shall be held responsible for the trueness of the surface of the pavement and shall be required to correct any deviation from the alignment, grade and cross-section as specified. Dusting with cement or sprinkling with water will not be permitted.

501.17 CURING

The concrete shall be cured by one of the methods listed below.

(A) MEMBRANE COMPOUND CURING. Membrane curing compound conforming to 814.03 shall be applied immediately after the final finishing of the surface by means of a mechanical sprayer conforming to 905.08. The curing compound shall be applied with an overlapping coverage which will give a two coat application at a coverage of not more than 150 square feet per gallon for both coats. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be stirred continuously by effective mechanical means. Spraying pressure shall be sufficient to produce a fine spray and cover the surface thoroughly and completely with a uniform film. The application of curing compound by hand operated pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms, as authorized by the Engineer. When application is made by hand operated sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat.

The compound shall form a uniform, continuous, coherent film that shall not check, crack or peel and shall be free from pin holes and other imperfections. If pin holes or other discontinuities exist, an additional coat shall be applied within 30 minutes to the affected areas. Concrete surfaces which are subject to heavy rainfall within three hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above, at no additional cost to the District.

Necessary precautions shall be taken to insure that none of the curing compound enters joints which are to be sealed. Rope of moistened paper, fiber or other suitable material shall be used to seal the top of the joint opening, and the concrete in the region of the joint shall be sprayed with curing compound immediately after the rope seal is installed. Other methods of protecting the joints may be used when approved by the Engineer.

Approved standby facilities or approved alternate methods for curing concrete pavement shall be provided at a readily accessible location at the site of the work for use in event of mechanical failure of the spraying equipment or any other conditions which may prevent correct application of the membrane curing compound at the proper time. In the event of a failure of the regular spraying equipment, the paving operation shall be suspended and the standby or alternate curing method shall be used only on the remaining portion of the pavement already placed.

When the air temperature will reach 90° F or above, 2 layers of water-saturated burlap shall be placed over the concrete after the application of the curing compound. The burlap shall be placed in accordance with the requirements for burlap curing and shall be kept wet for 24 hours.

(B) BURLAP CURING. Burlap meeting the requirements of 814.01 shall be placed as soon as it may be done without injury to the concrete. It shall be overlapped in half widths of strips so as to provide a

double thickness throughout its coverage. It shall be saturated prior to placement and placed wet. It shall be kept wet continuously for a minimum of 72 hours.

After the initial 72-hour period, the burlap may be removed providing that the concrete has developed a flexural strength of 450 psi as ascertained by testing in accordance with 501.15. If flexural strength tests are not made, or if the tests indicate strengths less than 450 psi, the concrete shall be cured an additional 4 days. The burlap shall be kept wet during the entire 7 day period.

The burlap shall be free from holes, earth or any substance that will interfere with its absorptive qualities or have a deleterious effect on the concrete. Any burlap which becomes contaminated with earth or other deleterious substances shall be washed clean prior to use.

(C) POLYETHYLENE SHEETING OR WATERPROOF PAPER CURING. As soon after finishing as practical without marring the surface, the pavement shall be covered with polyethylene sheeting conforming to 814.02(A) or waterproof paper conforming to 814.02(B). The cover shall be of sufficient width to provide a complete cover for the surface of the pavement, including face and top of all curbs and the edges of the pavement or curb when the forms are removed. The cover shall be carefully placed as directed to completely seal the surface without marring it. The cover shall be secured along the sides and ends to maintain a reasonably airtight seal and adjoining covers shall overlap at least 12 inches. Any material that is torn or does not provide an acceptable airtight seal shall not be used.

The concrete shall be kept covered a minimum of 72 hours. After the initial 72 hour period, the covering may be removed provided that the concrete has attained a flexural strength of 450 psi as ascertained by testing in conformance with 501.15. Otherwise, the concrete shall be kept covered 7 days.

501.18 REMOVING FORMS AND BACKFILLING

(A) REMOVAL OF FORMS. Forms shall not be removed in any case in less than 12 hours, and during periods of low temperatures (below 40° F), they shall not be removed in less than 48 hours. After the forms have been removed, the sides of the slab shall be cured by one of the methods specified in 501.17.

(B) BACKFILLING. Where concrete pavements are constructed without curbs, backfilling shall be performed within 24 hours after removal of the forms and shall consist of preparation of the shoulder adjacent to the pavement. Where concrete pavements are constructed with curbs, backfilling shall be done in accordance with 609.01(E)(7).

501.19 SEALING OF JOINTS

(A) TRANSVERSE JOINTS. All transverse expansion, contraction and construction joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including the Contractor's equipment. The sealing material shall conform to 807.02(A)(1) or (2).

Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing, and the joint faces shall be clean and surface dry when the seal is applied.

Cleaning shall be accomplished by the use of power tools approved by the Engineer. The use of any tools which result in damage to the pavement will not be permitted. Immediately prior to the actual sealing operation, the joints shall be thoroughly blown out with a jet of air having sufficient volume and pressure to remove any loose material left by the cleaning operation.

When hot poured-type joint sealing material is used it shall be heated to the temperature recommended by the manufacturer, but not to exceed 450° F at any stage during the melting or pouring

operations, in an approved melting- applicator apparatus meeting the requirements of 903.02.

The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by the Engineer. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. Any material heated beyond the recommended pouring temperature shall be rejected and removed from the apparatus, the apparatus thoroughly cleaned and new material heated to the proper temperature. Only sufficient material for the day's operations shall be heated at a time. When necessary to cut material into small chunks before putting it into the apparatus, the method used shall be approved by the Engineer.

The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

The joints shall be filled to within 1/4 inch of the finished pavement surface and the sealing material so placed that the resulting stripe will be straight and neat.

The use of sand or similar material as a cover for the seal will not be permitted. Poured joint sealing material shall not be placed when the air temperature in the shade is less than 50° F, unless approved by the Engineer.

(B) LONGITUDINAL JOINTS. When the edge of the first of separately constructed adjacent slabs is given a heavy coating of bituminous material as required in 501.14(B) it shall constitute the sealing of the longitudinal construction joint.

501.20 PROTECTION OF PAVEMENT

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers.

Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement replaced.

501.21 OPENING TO TRAFFIC

Vehicular traffic shall be excluded from pavement and pavement repairs for a minimum of 72 hours after the placement of curing materials. After the initial 72-hour period, if approved by the Engineer, the pavement may be opened to traffic providing that the concrete has developed a flexural strength of 550 psi or a compressive strength of 3500 psi as by testing in accordance with 501.15. If strength tests are not made, or if the required strengths are not attained, traffic shall be excluded for a minimum of 7 days after the concrete was placed.

The pavement shall be cleaned and all joints sealed prior to opening to traffic.

The cost of steel plating, if needed, shall be paid for as specified in 624.02.

501.22 HIGH EARLY STRENGTH CONCRETE

All specifications for standard portland cement concrete shall apply to high early strength concrete. High early strength concrete shall be produced by one of the following methods, or a combination thereof, as directed by the Engineer.

1. By the use of high early strength portland cement in lieu of the standard portland cement specified and in the same amount.

2. By the use of additional standard portland cement (the total amount of cement shall not exceed 1 bag over that required by the approved mix design).

3. By the use of a Type C accelerator meeting the requirements of 814.05 incorporated in the concrete mix.

Where the use of high early strength cement or additional standard cement is directed, the purpose being to produce a high early strength concrete to allow for earlier opening or completion of the project, the Contractor will be required to proceed with diligent prosecution of all phases of the work to insure the full benefit of the additional cost and an early opening.

Should the Contractor fail, refuse or neglect to complete the work properly and diligently so as to render it ready for traffic, such failure, refusal or neglect shall be sufficient reason to withhold payment for high early strength cement or the additional standard cement.

501.23 TOLERANCE IN PAVEMENT THICKNESS

The thickness of the constructed pavement will be determined by average caliper measurement of cores measured in accordance with AASHTO T 148. At such points as the Engineer may select, in each 500 linear lane feet or fraction thereof of pavement, 2 or more cores will be taken and measured. These cores will be taken by the District. The average thickness of each 500 feet of pavement will be determined from these cores. In calculating the average thickness of the pavement, measurements which are in excess of the thickness specified by more than 1/8 inch will be considered as the specified thickness plus 1/8 inch. Measurements which are less than the specified thickness by 1/2 inch or more shall not be included in the average. Disposition of pavement deficient by 1/2 inch or more in thickness will be as provided below.

For pavement slabs, the average thickness of which is 1/8 inch less than the thickness specified, the contract unit price shall be used in the payment.

For pavement slabs, the average thickness of which is less than the thickness specified by more than 1/8 inch, but less than 1/2 inch, an adjusted unit price shall bear the same ratio to the contract unit price as the square of the average thickness of the slab bears to the square of the thickness specified.

Additional payment over the contract unit price will not be made for any pavement with an average thickness in excess of the thickness specified.

The adjusted unit price shall be calculated for each 500 feet or fraction thereof in which the deficient core lane measurements are included.

Payment will not be made for pavement that is deficient by 1/2 inch but less than 1 inch in thickness. Such pavement shall either be removed and replaced with pavement of specified thickness at the Contractor's expense, or may remain in place without payment to the Contractor. Pavement deficient by 1 inch or more in thickness shall be removed and replaced at the Contractor's expense.

Where the specified method of determining thickness reveals pavement deficient in thickness by 1/2 inch or more, additional cores shall be made at intervals of 25 feet parallel to the centerline to determine the extent of the deficiencies greater than 1/2 inch. Determination of the extent of the areas to be replaced and/or areas for which no payment will be made will be based on these additional thickness determinations.

If the Contractor believes that the cores and measurements taken are insufficient to indicate fairly the actual thickness of pavement, he may request additional cores and measurements. Such measurements shall be at intervals not less than 200 feet. The cost of additional cores and measurements shall be deducted from sums due the Contractor unless such measurements indicated that the pavement within the area in question is of specified thickness.

501.24 MEASURE AND PAYMENT

Payment for the various items of work listed herein will include all costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

(A) REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT (Square Yard Method). The unit of measurement for Reinforced PCC Pavement will be the square yard. The actual number of square yards of the specified depth measured complete in place will be paid for at the contract unit price per square yard, or adjusted unit price per square yard if required under 501.23, which payment will include joints, waterproofing, load transfer devices, impervious material, reinforcement, sealing of joints and curing.

The width for measurement will be the width from the intersection of the face of the curb or gutter with the surface of the pavement on one side to the intersection of the face of the curb or gutter with the surface of the pavement on the other side. Where there is no curb or gutter, the width for measurement will be from outside edge to outside edge of the pavement. The length will be the actual length measured along the center line of the riding surface.

(B) REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT (Cubic Yard Method).

The unit of measure for Reinforced PCC Pavement will be the cubic yard. The actual number of cubic yards complete in place will be paid for at the contract unit price per cubic yard, or adjusted unit price per cubic yard if required under 501.23, which payment includes joints, waterproofing, load transfer devices, impervious material, reinforcement, sealing of joints and curing.

(C) PORTLAND CEMENT CONCRETE. The unit of measure for PCC will be the cubic yard. The actual number of additional cubic yards furnished complete in place for extra depth of concrete over trenches, around manholes, thickened edges, or for other use, as directed by the Engineer, will be paid for at the contract unit price per cubic yard.

(D) ADDITIONAL WIRE FABRIC REINFORCEMENT. The unit of measure for Additional Wire Fabric Reinforcement will be the square yard. The actual number of square yards measured complete in place, with no allowance for overlap, will be paid for at the contract unit price per square yard for the appropriate item listed in the Schedule of Prices.

(E) EXTRA PREFORMED EXPANSION JOINT. No separate payment will be made for preformed expansion joint material; it will be included in the payment of the appropriate PCC items.

(F) HIGH EARLY STRENGTH PORTLAND CEMENT. unit of measure for High Early Strength Portland Cement will be the bag. The actual number of bags incorporated in the mix in lieu of standard portland cement will be paid for at the contract unit price per bag, which payment shall be for the additional cost of high early strength portland cement over that of standard portland cement.

(G) ADDITIONAL STANDARD PORTLAND CEMENT. The unit of measure for Additional Standard Portland Cement will be the bag. The actual number of bags of additional cement added to the mix at the direction of the Engineer for the purpose of producing high early strength concrete will be paid

for at the contract unit price per bag.